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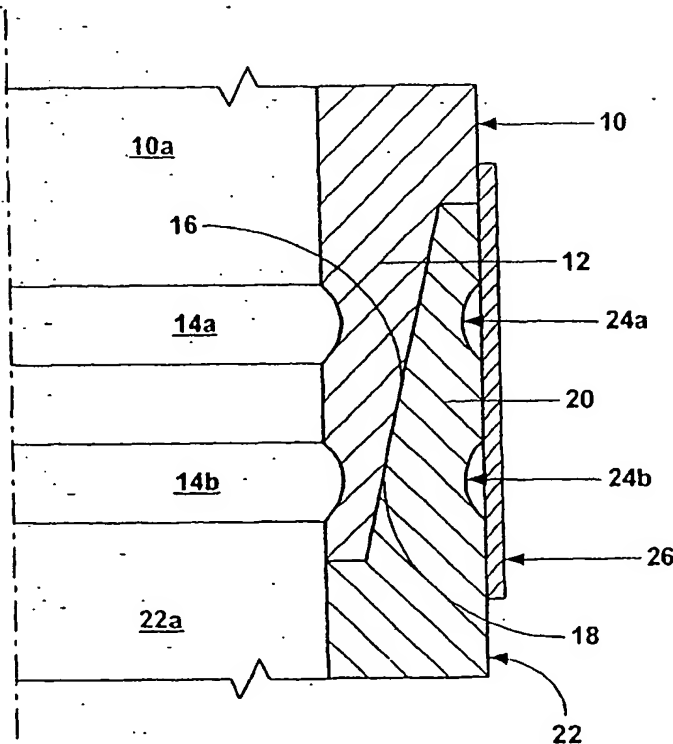
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[Continued on next page]

(54) Title: THREADED CONNECTION FOR EXPANDABLE TUBULARS

(57) Abstract: A threaded connection for expandable tubulars.

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THREADED CONNECTION FOR EXPANDABLE TUBULARS**Cross Reference To Related Applications**

[001] The present application claims the benefit of the filing dates of (1) U.S. provisional patent application serial no. 60/412,371, attorney docket no 25791.129, filed on 9/20/2002, the disclosure of which is incorporated herein-by reference.

[002] The present application is related to the following: (1) U.S. patent application serial no. 09/454,139, attorney docket no. 25791.03.02, filed on 12/3/1999, (2) U.S. patent application serial no. 09/510,913, attorney docket no. 25791.7.02, filed on 2/23/2000, (3) U.S. patent application serial no. 09/502,350, attorney docket no. 25791.8.02, filed on 2/10/2000, (4) U.S. patent no. 6,328,113, (5) U.S. patent application serial no. 09/523,460, attorney docket no. 25791.11.02, filed on 3/10/2000, (6) U.S. patent application serial no. 09/512,895, attorney docket no. 25791.12.02, filed on 2/24/2000, (7) U.S. patent application serial no. 09/511,941, attorney docket no. 25791.16.02, filed on 2/24/2000, (8) U.S. patent application serial no. 09/588,946, attorney docket no. 25791.17.02, filed on 6/7/2000, (9) U.S. patent application serial no. 09/559,122, attorney docket no. 25791.23.02, filed on 4/26/2000, (10) PCT patent application serial no. PCT/US00/18635, attorney docket no. 25791.25.02, filed on 7/9/2000, (11) U.S. provisional patent application serial no. 60/162,671, attorney docket no. 25791.27, filed on 11/1/1999, (12) U.S. provisional patent application serial no. 60/154,047, attorney docket no. 25791.29, filed on 9/16/1999, (13) U.S. provisional patent application serial no. 60/159,082, attorney docket no. 25791.34, filed on 10/12/1999, (14) U.S. provisional patent application serial no. 60/159,039, attorney docket no. 25791.36, filed on 10/12/1999, (15) U.S. provisional patent application serial no. 60/159,033, attorney docket no. 25791.37, filed on 10/12/1999, (16) U.S. provisional patent application serial no. 60/212,359, attorney docket no. 25791.38, filed on 6/19/2000, (17) U.S. provisional patent application serial no. 60/165,228, attorney docket no. 25791.39, filed on 11/12/1999, (18) U.S. provisional patent application serial no. 60/221,443, attorney docket no. 25791.45, filed on 7/28/2000, (19) U.S. provisional patent application serial no. 60/221,645, attorney docket no. 25791.46, filed on 7/28/2000, (20) U.S. provisional patent application serial no. 60/233,638, attorney docket no. 25791.47, filed on 9/18/2000, (21) U.S. provisional patent application serial no. 60/237,334, attorney docket no. 25791.48, filed on 10/2/2000, (22) U.S. provisional patent application serial no. 60/270,007, attorney docket no. 25791.50, filed on 2/20/2001, (23) U.S. provisional patent application serial no. 60/262,434, attorney docket no. 25791.51, filed on 1/17/2001, (24) U.S. provisional patent application serial no. 60/259,486, attorney docket no. 25791.52, filed on 1/3/2001, (25) U.S. provisional patent application serial no. 60/303,740, attorney docket no. 25791.61, filed on 7/6/2001, (26) U.S. provisional patent application serial no. 60/313,453, attorney docket no. 25791.59, filed on 8/20/2001, (27) U.S. provisional patent application serial no. 60/317,985, attorney docket no. 25791.67, filed on 9/6/2001, (28) U.S. provisional patent application serial no. 60/3318,386, attorney docket no. 25791.67.02, filed on 9/10/2001, (29) U.S. utility patent application serial no. 09/969,922, attorney docket no. 25791.69, filed on 10/3/2001, (30) U.S. utility

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Background of the Invention

[003] This invention relates generally to oil and gas exploration, and in particular to forming and repairing wellbore casings to facilitate oil and gas exploration.

[004] Conventionally, when a wellbore is created, a number of casings are installed in the borehole to prevent collapse of the borehole wall and to prevent undesired outflow of drilling fluid into the formation or inflow of fluid from the formation into the borehole. The borehole is drilled in intervals whereby a casing which is to be installed in a lower borehole interval is lowered through a previously installed casing of an upper borehole interval. As a consequence of this procedure the casing of the lower interval is of smaller diameter than the casing of the upper interval. Thus, the casings are in a nested arrangement with casing diameters decreasing in downward direction. Cement annuli are provided between the outer surfaces of the casings and the borehole wall to seal the casings from the borehole wall. As a consequence of this nested arrangement a relatively large borehole diameter is required at the upper part of the wellbore. Such a large borehole diameter involves increased costs due

to heavy casing handling equipment, large drill bits and increased volumes of drilling fluid and drill cuttings. Moreover, increased drilling rig time is involved due to required cement pumping, cement hardening, required equipment changes due to large variations in hole diameters drilled in the course of the well, and the large volume of cuttings drilled and removed.

[005] During oil exploration, a wellbore typically traverses a number of zones within a subterranean formation. Wellbore casings are then formed in the wellbore by radially expanding and plastically deforming tubular members that are coupled to one another by threaded connections existing methods for radially expanding and plastically deforming tubular members coupled to one another by threaded connections are not always reliable and do not always produce satisfactory results. In particular, the threaded connections can be damaged during the radial expansion process. Furthermore, the threaded connections between adjacent tubular members, whether radially expanded or not, are typically not sufficiently coupled to permit the transmission of energy through the tubular members from the surface to the downhole location. Further, the damaged threads may permit undesirable leakage between the inside of the casing and the exterior of the casing.

[006] The present invention is directed to overcoming one or more of the limitations of the existing procedures for forming and/or repairing wellbore casings.

Summary of the Invention

[007] According to one aspect of the present invention, an assembly is provided that includes a first tubular member including external threads, and a second tubular member comprising internal threads coupled to the external threads of the first tubular member. At least one of the first and second tubular members define one or more stress concentrators. According to another aspect of the present invention, a method for forming a wellbore casing has been described that includes positioning any one, portion, or combination, of the exemplary embodiments of the assemblies of the present application within a borehole that traverses a subterranean formation, and radially expanding and plastically deforming the assembly within the borehole.

[008] According to another aspect of the present invention, an apparatus is provided that includes a wellbore that traverses a subterranean formation, and a wellbore casing positioned within and coupled to the wellbore. The wellbore casing is coupled to the wellbore by a process including: positioning any one, portion, or combination, of the exemplary assemblies of the present application within the wellbore, and radially expanding and plastically deforming the assembly within the wellbore.

[009] According to another aspect of the present invention, a system for forming a wellbore casing is provided that includes means for positioning any one, portion, or combination, of the exemplary assemblies of the present application within a borehole that traverses a subterranean formation, and means for radially expanding and plastically deforming the assembly within the borehole.

[0010] According to another aspect of the present invention, a method of providing a fluid tight seal between a pair of overlapping tubular members is provided that includes forming one or more stress

concentrators within at least one of the tubular members, and radially expanding and plastically deforming the tubular members.

Brief Description of the Drawings

[0011] Fig. 1 is a fragmentary cross-sectional illustration of a first tubular threadably coupled to a second tubular.

[0012] Fig. 2 is a fragmentary cross-sectional illustration of a first tubular threadably coupled to a second tubular.

Detailed Description of the Illustrative Embodiments

[0013] Fig. 1 illustrates a first tubular member 10 that defines a passage 10a that includes a pin member 12 that includes stress concentration grooves, 14a and 14b, formed in the internal surface of the pin member, and external threads 16 that engage internal threads 18 of a box member 20 of a second tubular member 22 that defines a passage 22a. Stress concentration grooves, 24a and 24b, are formed in the external surface of the box member 20 of the second tubular member, and an external sleeve 26 is coupled to and overlaps with the ends of the first and second tubular members, 10 and 22. The first tubular member 10, the second tubular member 22, and the external sleeve 26 may be radially expanded and plastically deformed using any number of conventional methods and apparatus and/or as disclosed in one or more of the following: (1) U.S. patent application serial no. 09/454,139, attorney docket no. 25791.03.02, filed on 12/3/1999, (2) U.S. patent application serial no. 09/510,913, attorney docket no. 25791.7.02, filed on 2/23/2000, (3) U.S. patent application serial no. 09/502,350, attorney docket no. 25791.8.02, filed on 2/10/2000, (4) U.S. patent no. 6,328,113, (5) U.S. patent application serial no. 09/523,460, attorney docket no. 25791.11.02, filed on 3/10/2000, (6) U.S. patent application serial no. 09/512,895, attorney docket no. 25791.12.02, filed on 2/24/2000, (7) U.S. patent application serial no. 09/511,941, attorney docket no. 25791.16.02, filed on 2/24/2000, (8) U.S. patent application serial no. 09/588,946, attorney docket no. 25791.17.02, filed on 6/7/2000, (9) U.S. patent application serial no. 09/559,122, attorney docket no. 25791.23.02, filed on 4/26/2000, (10) PCT patent application serial no. PCT/US00/18635, attorney docket no. 25791.25.02, filed on 7/9/2000, (11) U.S. provisional patent application serial no. 60/162,671, attorney docket no. 25791.27, filed on 11/1/1999, (12) U.S. provisional patent application serial no. 60/154,047, attorney docket no. 25791.29, filed on 9/16/1999, (13) U.S. provisional patent application serial no. 60/159,082, attorney docket no. 25791.34, filed on 10/12/1999, (14) U.S. provisional patent application serial no. 60/159,039, attorney docket no. 25791.36, filed on 10/12/1999, (15) U.S. provisional patent application serial no. 60/159,033, attorney docket no. 25791.37, filed on 10/12/1999, (16) U.S. provisional patent application serial no. 60/212,359, attorney docket no. 25791.38, filed on 6/19/2000, (17) U.S. provisional patent application serial no. 60/165,228, attorney docket no. 25791.39, filed on 11/12/1999, (18) U.S. provisional patent application serial no. 60/221,443, attorney docket no. 25791.45, filed on 7/28/2000, (19) U.S. provisional patent application serial no. 60/221,645, attorney

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[0014] In an exemplary embodiment, during the radial expansion and plastic deformation of the first tubular member 10, the second tubular member 22, and the external sleeve 26, the stress concentration grooves, 14a, 14b, 24a, and 24b, concentrate compressive stresses onto the threads, 16 and 18, of the pin and box members, 12 and 20, of the first and second tubular members to drive the threads together to thereby provide a fluid tight seal between the threads of the pin and box members of the first and second tubular members upon the completion of the radial expansion and plastic deformation.

[0015] Fig. 2 is an illustration of another illustrative embodiment.

[0016] An assembly has been described that includes a first tubular member including external threads, and a second tubular member comprising internal threads coupled to the external threads of the first tubular member. At least one of the first and second tubular members define one or more stress concentrators. In an exemplary embodiment, the assembly further comprises an external sleeve coupled to and overlapping with the ends of the first and second tubular members. In an exemplary embodiment, one or more of the stress concentrators comprise surface grooves formed in the surfaces of at least one of the first and second tubular members. In an exemplary embodiment, the stress concentrators are defined above the internal and external threads of the first and second tubular members.

[0017] A method for forming a wellbore casing has been described that includes positioning any one, portion, or combination, of the exemplary embodiments of the assemblies of the present application within a borehole that traverses a subterranean formation, and radially expanding and plastically deforming the assembly within the borehole.

[0018] An apparatus has been described that includes a wellbore that traverses a subterranean formation, and a wellbore casing positioned within and coupled to the wellbore. The wellbore casing is coupled to the wellbore by a process including: positioning any one, portion, or combination, of the exemplary assemblies of the present application within the wellbore, and radially expanding and plastically deforming the assembly within the wellbore.

[0019] A system for forming a wellbore casing has been described that includes means for positioning any one, portion, or combination, of the exemplary assemblies of the present application within a borehole that traverses a subterranean formation, and means for radially expanding and plastically deforming the assembly within the borehole.

[0020] A method of providing a fluid tight seal between a pair of overlapping tubular members has been described that includes forming one or more stress concentrators within at least one of the tubular members, and radially expanding and plastically deforming the tubular members. In an exemplary embodiment, the tubular members are threadably coupled, and the stress concentrators are formed above the threaded coupling.

[0021] In an exemplary embodiment, the stress concentrators comprise surface grooves formed in at least one of the tubular members.

[0022] It is understood that variations may be made in the foregoing without departing from the scope of

the invention. For example, the teachings of the present illustrative embodiments may be used to provide an insulated wellbore casing, a pipeline, or a structural support. Furthermore, the elements and teachings of the various illustrative embodiments may be combined in whole or in part in some or all of the illustrative embodiments. In addition, the external sleeve 26 may be omitted. Furthermore, one or more of the stress concentration grooves, 14a, 14b, 24a, and/or 24b, may be omitted. In addition, the stress concentration grooves, 14a, 14b, 24a, and/or 24b may be provided in any geometric shape capable of concentrating stresses. Furthermore, the stress concentration grooves, 14a and 14b, may or may not be positioned in opposing relation to the stress concentration grooves, 24a and 24b. In addition, the first and second tubular members, 10 and 22, may or may not be threadably coupled to one another, and the threads, 16 and 18, of the first and second tubular members may be any type of threads.

[0023] Although illustrative embodiments of the invention have been shown and described, a wide range of modification, changes and substitution is contemplated in the foregoing disclosure. In some instances, some features of the present invention may be employed without a corresponding use of the other features. Accordingly, it is appropriate that the appended claims be construed broadly and in a manner consistent with the scope of the invention.

Claims

1. An assembly, comprising:
a first tubular member comprising external threads; and
a second tubular member comprising internal threads coupled to the external threads of the first tubular member;
wherein at least one of the first and second tubular members define one or more stress concentrators.
2. The assembly of claim 1, further comprising:
an external sleeve coupled to and overlapping with the ends of the first and second tubular members.
3. The assembly of claim 1, wherein one or more of the stress concentrators comprise surface grooves formed in the surfaces of at least one of the first and second tubular members.
4. The assembly of claim 1, wherein the stress concentrators are defined above the internal and external threads of the first and second tubular members.
5. A method for forming a wellbore casing, comprising:
positioning the assembly of claim 1 within a borehole that traverses a subterranean formation; and
radially expanding and plastically deforming the assembly within the borehole.
6. A method for forming a wellbore casing, comprising:
positioning the assembly of claim 2 within a borehole that traverses a subterranean formation; and
radially expanding and plastically deforming the assembly within the borehole.
7. A method for forming a wellbore casing, comprising:
positioning the assembly of claim 3 within a borehole that traverses a subterranean formation; and
radially expanding and plastically deforming the assembly within the borehole.
8. A method for forming a wellbore casing, comprising:
positioning the assembly of claim 4 within a borehole that traverses a subterranean formation; and
radially expanding and plastically deforming the assembly within the borehole.
9. An apparatus, comprising:
a wellbore that traverses a subterranean formation; and
a wellbore casing positioned within and coupled to the wellbore;
wherein the wellbore casing is coupled to the wellbore by a process comprising:
positioning the assembly of claim 1 within the wellbore; and
radially expanding and plastically deforming the assembly within the wellbore.
10. An apparatus, comprising:
a wellbore that traverses a subterranean formation; and
a wellbore casing positioned within and coupled to the wellbore;
wherein the wellbore casing is coupled to the wellbore by a process comprising:

positioning the assembly of claim 2 within the wellbore; and
radially expanding and plastically deforming the assembly within the wellbore.

11. An apparatus, comprising:
a wellbore that traverses a subterranean formation; and
a wellbore casing positioned within and coupled to the wellbore;
wherein the wellbore casing is coupled to the wellbore by a process comprising:
positioning the assembly of claim 3 within the wellbore; and
radially expanding and plastically deforming the assembly within the wellbore.
12. An apparatus, comprising:
a wellbore that traverses a subterranean formation; and
a wellbore casing positioned within and coupled to the wellbore;
wherein the wellbore casing is coupled to the wellbore by a process comprising:
positioning the assembly of claim 4 within the wellbore; and
radially expanding and plastically deforming the assembly within the wellbore.
15. A system for forming a wellbore casing, comprising:
means for positioning the assembly of claim 1 within a borehole that traverses a subterranean formation; and
means for radially expanding and plastically deforming the assembly within the borehole.
16. A system for forming a wellbore casing, comprising:
means for positioning the assembly of claim 2 within a borehole that traverses a subterranean formation; and
means for radially expanding and plastically deforming the assembly within the borehole.
17. A system for forming a wellbore casing, comprising:
means for positioning the assembly of claim 3 within a borehole that traverses a subterranean formation; and
means for radially expanding and plastically deforming the assembly within the borehole.
18. A system for forming a wellbore casing, comprising:
means for positioning the assembly of claim 4 within a borehole that traverses a subterranean formation; and
means for radially expanding and plastically deforming the assembly within the borehole.
19. A method of providing a fluid tight seal between a pair of overlapping tubular members, comprising:
forming one or more stress concentrators within at least one of the tubular members; and
radially expanding and plastically deforming the tubular members.
20. The method of claim 19, wherein the tubular members are threadably coupled; and
wherein the stress concentrators are formed above the threaded coupling.

21. The method of claim 19, wherein the stress concentrators comprise surface grooves formed in at least one of the tubular members.

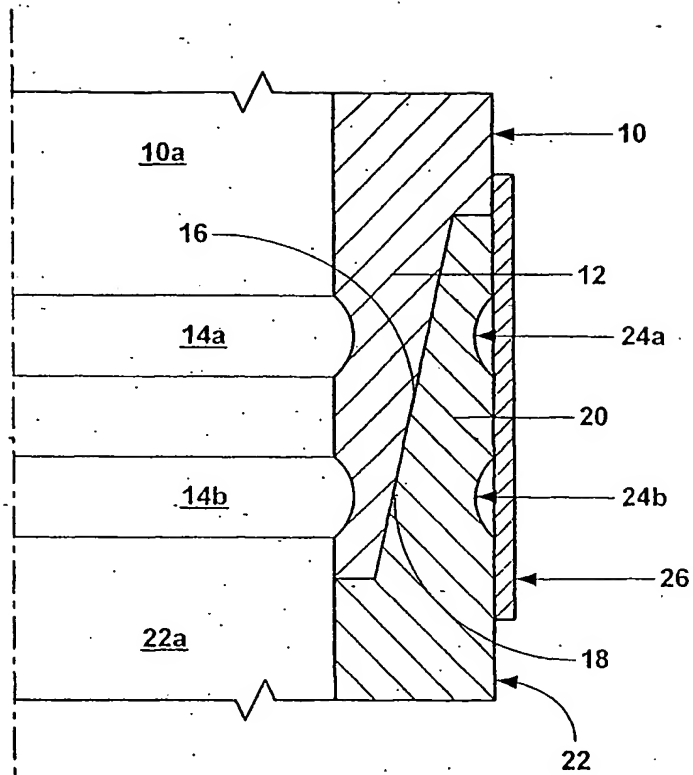


Fig. 1

29 AUGUST 2002
JOSE R. MENCHACA, JR
August 29, 2002
Jose R. Menchaca, Jr.

Scott Gestra
Scott Gestra

By Controlling "Necking" or Movement
of Material during the EXPANSION
Process, INDUCED STRESS (CONTACTS)
CAN OCCUR at the Box/PIN thread
INTERFACE.
Create varying cross-sectional
areas over the threads to
induce contact pressure during
expansion process.

KNOWN:

- 1) MPT %
- 2) EXP %
- 3) AREA EXP
- 4) Necking

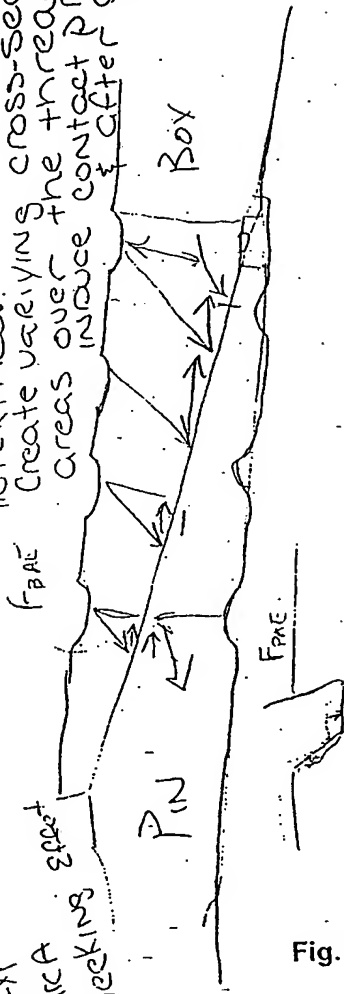
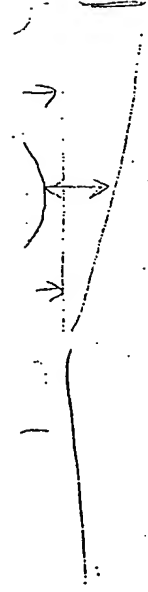


Fig. 2



CORRECTED VERSION



PCT

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224 225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249 250 251 252 253 254 255 256 257 258 259 260 261 262 263 264 265 266 267 268 269 270 271 272 273 274 275 276 277 278 279 280 281 282 283 284 285 286 287 288 289 290 291 292 293 294 295 296 297 298 299 300 301 302 303 304 305 306 307 308 309 310 311 312 313 314 315 316 317 318 319 320 321 322 323 324 325 326 327 328 329 330 331 332 333 334 335 336 337 338 339 340 341 342 343 344 345 346 347 348 349 350 351 352 353 354 355 356 357 358 359 360 361 362 363 364 365 366 367 368 369 370 371 372 373 374 375 376 377 378 379 380 381 382 383 384 385 386 387 388 389 390 391 392 393 394 395 396 397 398 399 400 401 402 403 404 405 406 407 408 409 410 411 412 413 414 415 416 417 418 419 420 421 422 423 424 425 426 427 428 429 430 431 432 433 434 435 436 437 438 439 440 441 442 443 444 445 446 447 448 449 450 451 452 453 454 455 456 457 458 459 460 461 462 463 464 465 466 467 468 469 470 471 472 473 474 475 476 477 478 479 480 481 482 483 484 485 486 487 488 489 490 491 492 493 494 495 496 497 498 499 500 501 502 503 504 505 506 507 508 509 510 511 512 513 514 515 516 517 518 519 520 521 522 523 524 525 526 527 528 529 530 531 532 533 534 535 536 537 538 539 540 541 542 543 544 545 546 547 548 549 550 551 552 553 554 555 556 557 558 559 560 561 562 563 564 565 566 567 568 569 570 571 572 573 574 575 576 577 578 579 580 581 582 583 584 585 586 587 588 589 590 591 592 593 594 595 596 597 598 599 600 601 602 603 604 605 606 607 608 609 610 611 612 613 614 615 616 617 618 619 620 621 622 623 624 625 626 627 628 629 630 631 632 633 634 635 636 637 638 639 640 641 642 643 644 645 646 647 648 649 650 651 652 653 654 655 656 657 658 659 660 661 662 663 664 665 666 667 668 669 670 671 672 673 674 675 676 677 678 679 680 681 682 683 684 685 686 687 688 689 690 691 692 693 694 695 696 697 698 699 700 701 702 703 704 705 706 707 708 709 710 711 712 713 714 715 716 717 718 719 720 721 722 723 724 725 726 727 728 729 730 731 732 733 734 735 736 737 738 739 740 741 742 743 744 745 746 747 748 749 750 751 752 753 754 755 756 757 758 759 760 761 762 763 764 765 766 767 768 769 770 771 772 773 774 775 776 777 778 779 780 781 782 783 784 785 786 787 788 789 790 791 792 793 794 795 796 797 798 799 800 801 802 803 804 805 806 807 808 809 810 811 812 813 814 815 816 817 818 819 820 821 822 823 824 825 826 827 828 829 830 831 832 833 834 835 836 837 838 839 840 841 842 843 844 845 846 847 848 849 850 851 852 853 854 855 856 857 858 859 860 861 862 863 864 865 866 867 868 869 870 871 872 873 874 875 876 877 878 879 880 881 882 883 884 885 886 887 888 889 890 891 892 893 894 895 896 897 898 899 900 901 902 903 904 905 906 907 908 909 910 911 912 913 914 915 916 917 918 919 920 921 922 923 924 925 926 927 928 929 930 931 932 933 934 935 936 937 938 939 940 941 942 943 944 945 946 947 948 949 950 951 952 953 954 955 956 957 958 959 960 961 962 963 964 965 966 967 968 969 970 971 972 973 974 975 976 977 978 979 980 981 982 983 984 985 986 987 988 989 990 991 992 993 994 995 996 997 998 999 1000 1001 1002 1003 1004 1005 1006 1007 1008 1009 1010 1011 1012 1013 1014 1015 1016 1017 1018 1019 1020 1021 1022 1023 1024 1025 1026 1027 1028 1029 1030 1031 1032 1033 1034 1035 1036 1037 1038 1039 1040 1

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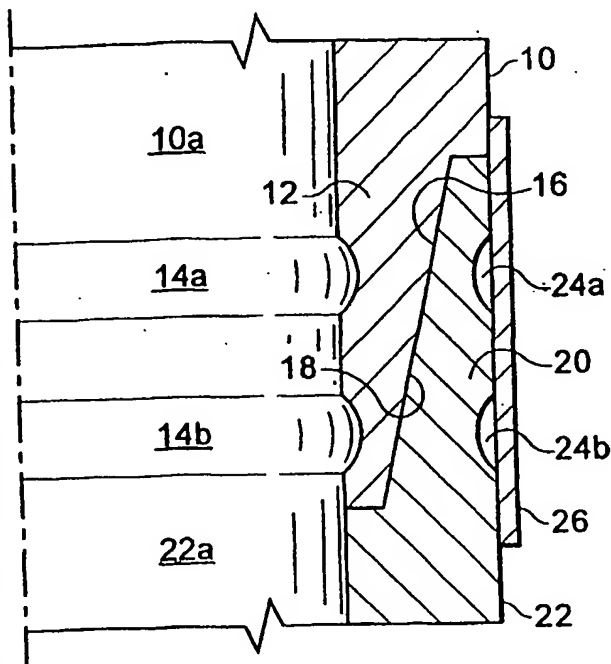
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(57) **Abstract:** A threaded connection for expandable tubulars.



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THREADED CONNECTION FOR EXPANDABLE TUBULARS**Cross Reference To Related Applications**

[001] The present application claims the benefit of the filing dates of (1) U.S. provisional patent application serial no. 60/412,371, attorney docket no 25791.129, filed on 9/20/2002, the disclosure of which is incorporated herein by reference.

[002] The present application is related to the following: (1) U.S. patent application serial no. 09/454,139, attorney docket no. 25791.03.02, filed on 12/3/1999, (2) U.S. patent application serial no. 09/510,913, attorney docket no. 25791.7.02, filed on 2/23/2000, (3) U.S. patent application serial no. 09/502,350, attorney docket no. 25791.8.02, filed on 2/10/2000, (4) U.S. patent no. 6,328,113, (5) U.S. patent application serial no. 09/523,460, attorney docket no. 25791.11.02, filed on 3/10/2000, (6) U.S. patent application serial no. 09/512,895, attorney docket no. 25791.12.02, filed on 2/24/2000, (7) U.S. patent application serial no. 09/511,941, attorney docket no. 25791.16.02, filed on 2/24/2000, (8) U.S. patent application serial no. 09/588,946, attorney docket no. 25791.17.02, filed on 6/7/2000, (9) U.S. patent application serial no. 09/559,122, attorney docket no. 25791.23.02, filed on 4/26/2000, (10) PCT patent application serial no. PCT/US00/18635, attorney docket no. 25791.25.02, filed on 7/9/2000, (11) U.S. provisional patent application serial no. 60/162,671, attorney docket no. 25791.27, filed on 11/1/1999, (12) U.S. provisional patent application serial no. 60/154,047, attorney docket no. 25791.29, filed on 9/16/1999, (13) U.S. provisional patent application serial no. 60/159,082, attorney docket no. 25791.34, filed on 10/12/1999, (14) U.S. provisional patent application serial no. 60/159,039, attorney docket no. 25791.36, filed on 10/12/1999, (15) U.S. provisional patent application serial no. 60/159,033, attorney docket no. 25791.37, filed on 10/12/1999, (16) U.S. provisional patent application serial no. 60/212,359, attorney docket no. 25791.38, filed on 6/19/2000, (17) U.S. provisional patent application serial no. 60/165,228, attorney docket no. 25791.39, filed on 11/12/1999, (18) U.S. provisional patent application serial no. 60/221,443, attorney docket no. 25791.45, filed on 7/28/2000, (19) U.S. provisional patent application serial no. 60/221,645, attorney docket no. 25791.46, filed on 7/28/2000, (20) U.S. provisional patent application serial no. 60/233,638, attorney docket no. 25791.47, filed on 9/18/2000, (21) U.S. provisional patent application serial no. 60/237,334, attorney docket no. 25791.48, filed on 10/2/2000, (22) U.S. provisional patent application serial no. 60/270,007, attorney docket no. 25791.50, filed on 2/20/2001, (23) U.S. provisional patent application serial no. 60/262,434, attorney docket no. 25791.51, filed on 1/17/2001, (24) U.S. provisional patent application serial no. 60/259,486, attorney docket no. 25791.52, filed on 1/3/2001, (25) U.S. provisional patent application serial no. 60/303,740, attorney docket no. 25791.61, filed on 7/6/2001, (26) U.S. provisional patent application serial no. 60/313,453, attorney docket no. 25791.59, filed on 8/20/2001, (27) U.S. provisional patent application serial no. 60/317,985, attorney docket no. 25791.67, filed on 9/6/2001, (28) U.S. provisional patent application serial no. 60/3318,386, attorney docket no. 25791.67.02, filed on 9/10/2001, (29) U.S. utility patent application serial no. 09/969,922, attorney docket no. 25791.69, filed on 10/3/2001, (30) U.S. utility

patent application serial no. 10/016,467, attorney docket no. 25791.70, filed on 12/10/2001, (31) U.S. provisional patent application serial no. 60/343,674, attorney docket no. 25791.68, filed on 12/27/2001, (32) U.S. provisional patent application serial no. 60/346,309, attorney docket no. 25791.92, filed on 1/7/2002, (33) U.S. provisional patent application serial no. 60/372,048, attorney docket no. 25791.93, filed on 4/12/2002, (34) U.S. provisional patent application serial no. 60/380,147, attorney docket no. 25791.104, filed on 5/6/2002, (35) U.S. provisional patent application serial no. 60/387,486, attorney docket no. 25791.107, filed on 6/10/2002, (36) U.S. provisional patent application serial no. 60/387,961, attorney docket no. 25791.108, filed on 6/12/2002, (37) U.S. provisional patent application serial no. 60/394,703, attorney docket no. 25791.90, filed on 6/26/2002, (38) U.S. provisional patent application serial no. 60/397,284, attorney docket no. 25791.106, filed on 7/19/2002, (39) U.S. provisional patent application serial no. 60/398,061, attorney docket no. 25791.110, filed on 7/24/2002, (40) U.S. provisional patent application serial no. 60/405,610, attorney docket no. 25791.119, filed on 8/23/2002, (41) U.S. provisional patent application serial no. 60/405,394, attorney docket no. 25791.120, filed on 8/23/2002, (42) U.S. provisional patent application serial no. 60/412,177, attorney docket no. 25791.117, filed on 9/20/2002, (43) U.S. provisional patent application serial no. 60/412,653, attorney docket no. 25791.118, filed on 9/20/2002, (44) U.S. provisional patent application serial no. 60/412,544, attorney docket no. 25791.121, filed on 9/20/2002, (45) U.S. provisional patent application serial no. 60/412,187, attorney docket no. 25791.128, filed on 9/20/2002, (46) U.S. provisional patent application serial no. 60/412,196, attorney docket no. 25791.127, filed on 9/20/2002, (47) U.S. provisional patent application serial no. 60/412,542, attorney docket no. 25791.102, filed on 9/20/2002, (48) U.S. provisional patent application serial no. 60/412,487, attorney docket no. 25791.112, filed on 9/20/2002, (49) U.S. provisional patent application no. 60/412,488, attorney docket no. 25791.114, filed on 9/20/2002, the disclosures of which are incorporated herein by reference.

Background of the Invention

[003] This invention relates generally to oil and gas exploration, and in particular to forming and repairing wellbore casings to facilitate oil and gas exploration.

[004] Conventionally, when a wellbore is created, a number of casings are installed in the borehole to prevent collapse of the borehole wall and to prevent undesired outflow of drilling fluid into the formation or inflow of fluid from the formation into the borehole. The borehole is drilled in intervals whereby a casing which is to be installed in a lower borehole interval is lowered through a previously installed casing of an upper borehole interval. As a consequence of this procedure the casing of the lower interval is of smaller diameter than the casing of the upper interval. Thus, the casings are in a nested arrangement with casing diameters decreasing in downward direction. Cement annuli are provided between the outer surfaces of the casings and the borehole wall to seal the casings from the borehole wall. As a consequence of this nested arrangement a relatively large borehole diameter is required at the upper part of the wellbore. Such a large borehole diameter involves increased costs due

to heavy casing handling equipment, large drill bits and increased volumes of drilling fluid and drill cuttings. Moreover, increased drilling rig time is involved due to required cement pumping, cement hardening, required equipment changes due to large variations in hole diameters drilled in the course of the well, and the large volume of cuttings drilled and removed.

[005] During oil exploration, a wellbore typically traverses a number of zones within a subterranean formation. Wellbore casings are then formed in the wellbore by radially expanding and plastically deforming tubular members that are coupled to one another by threaded connections existing methods for radially expanding and plastically deforming tubular members coupled to one another by threaded connections are not always reliable and do not always produce satisfactory results. In particular, the threaded connections can be damaged during the radial expansion process. Furthermore, the threaded connections between adjacent tubular members, whether radially expanded or not, are typically not sufficiently coupled to permit the transmission of energy through the tubular members from the surface to the downhole location. Further, the damaged threads may permit undesirable leakage between the inside of the casing and the exterior of the casing.

[006] The present invention is directed to overcoming one or more of the limitations of the existing procedures for forming and/or repairing wellbore casings.

Summary of the Invention

[007] According to one aspect of the present invention, an assembly is provided that includes a first tubular member including external threads, and a second tubular member comprising internal threads coupled to the external threads of the first tubular member. At least one of the first and second tubular members define one or more stress concentrators. According to another aspect of the present invention, a method for forming a wellbore casing has been described that includes positioning any one, portion, or combination, of the exemplary embodiments of the assemblies of the present application within a borehole that traverses a subterranean formation, and radially expanding and plastically deforming the assembly within the borehole.

[008] According to another aspect of the present invention, an apparatus is provided that includes a wellbore that traverses a subterranean formation, and a wellbore casing positioned within and coupled to the wellbore. The wellbore casing is coupled to the wellbore by a process including: positioning any one, portion, or combination, of the exemplary assemblies of the present application within the wellbore, and radially expanding and plastically deforming the assembly within the wellbore.

[009] According to another aspect of the present invention, a system for forming a wellbore casing is provided that includes means for positioning any one, portion, or combination, of the exemplary assemblies of the present application within a borehole that traverses a subterranean formation, and means for radially expanding and plastically deforming the assembly within the borehole.

[0010] According to another aspect of the present invention, a method of providing a fluid tight seal between a pair of overlapping tubular members is provided that includes forming one or more stress

concentrators within at least one of the tubular members, and radially expanding and plastically deforming the tubular members.

Brief Description of the Drawings

[0011] Fig. 1 is a fragmentary cross-sectional illustration of a first tubular threadably coupled to a second tubular.

[0012] Fig. 2 is a fragmentary cross-sectional illustration of a first tubular threadably coupled to a second tubular.

Detailed Description of the Illustrative Embodiments

[0013] Fig. 1 illustrates a first tubular member 10 that defines a passage 10a that includes a pin member 12 that includes stress concentration grooves, 14a and 14b, formed in the internal surface of the pin member, and external threads 16 that engage internal threads 18 of a box member 20 of a second tubular member 22 that defines a passage 22a. Stress concentration grooves, 24a and 24b, are formed in the external surface of the box member 20 of the second tubular member, and an external sleeve 26 is coupled to and overlaps with the ends of the first and second tubular members, 10 and 22. The first tubular member 10, the second tubular member 22, and the external sleeve 26 may be radially expanded and plastically deformed using any number of conventional methods and apparatus and/or as disclosed in one or more of the following: (1) U.S. patent application serial no. 09/454,139, attorney docket no. 25791.03.02, filed on 12/3/1999, (2) U.S. patent application serial no. 09/510,913, attorney docket no. 25791.7.02, filed on 2/23/2000, (3) U.S. patent application serial no. 09/502,350, attorney docket no. 25791.8.02, filed on 2/10/2000, (4) U.S. patent no. 6,328,113, (5) U.S. patent application serial no. 09/523,460, attorney docket no. 25791.11.02, filed on 3/10/2000, (6) U.S. patent application serial no. 09/512,895, attorney docket no. 25791.12.02, filed on 2/24/2000, (7) U.S. patent application serial no. 09/511,941, attorney docket no. 25791.16.02, filed on 2/24/2000, (8) U.S. patent application serial no. 09/588,946, attorney docket no. 25791.17.02, filed on 6/7/2000, (9) U.S. patent application serial no. 09/559,122, attorney docket no. 25791.23.02, filed on 4/26/2000, (10) PCT patent application serial no. PCT/US00/18635, attorney docket no. 25791.25.02, filed on 7/9/2000, (11) U.S. provisional patent application serial no. 60/162,671, attorney docket no. 25791.27, filed on 11/1/1999, (12) U.S. provisional patent application serial no. 60/154,047, attorney docket no. 25791.29, filed on 9/16/1999, (13) U.S. provisional patent application serial no. 60/159,082, attorney docket no. 25791.34, filed on 10/12/1999, (14) U.S. provisional patent application serial no. 60/159,039, attorney docket no. 25791.36, filed on 10/12/1999, (15) U.S. provisional patent application serial no. 60/159,033, attorney docket no. 25791.37, filed on 10/12/1999, (16) U.S. provisional patent application serial no. 60/212,359, attorney docket no. 25791.38, filed on 6/19/2000, (17) U.S. provisional patent application serial no. 60/165,228, attorney docket no. 25791.39, filed on 11/12/1999, (18) U.S. provisional patent application serial no. 60/221,443, attorney docket no. 25791.45, filed on 7/28/2000, (19) U.S. provisional patent application serial no. 60/221,645, attorney

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[0014] In an exemplary embodiment, during the radial expansion and plastic deformation of the first tubular member 10, the second tubular member 22, and the external sleeve 26, the stress concentration grooves, 14a, 14b, 24a, and 24b, concentrate compressive stresses onto the threads, 16 and 18, of the pin and box members, 12 and 20, of the first and second tubular members to drive the threads together to thereby provide a fluid tight seal between the threads of the pin and box members of the first and second tubular members upon the completion of the radial expansion and plastic deformation.

[0015] Fig. 2 is an illustration of another illustrative embodiment.

[0016] An assembly has been described that includes a first tubular member including external threads, and a second tubular member comprising internal threads coupled to the external threads of the first tubular member. At least one of the first and second tubular members define one or more stress concentrators. In an exemplary embodiment, the assembly further comprises an external sleeve coupled to and overlapping with the ends of the first and second tubular members. In an exemplary embodiment, one or more of the stress concentrators comprise surface grooves formed in the surfaces of at least one of the first and second tubular members. In an exemplary embodiment, the stress concentrators are defined above the internal and external threads of the first and second tubular members.

[0017] A method for forming a wellbore casing has been described that includes positioning any one, portion, or combination, of the exemplary embodiments of the assemblies of the present application within a borehole that traverses a subterranean formation, and radially expanding and plastically deforming the assembly within the borehole.

[0018] An apparatus has been described that includes a wellbore that traverses a subterranean formation, and a wellbore casing positioned within and coupled to the wellbore. The wellbore casing is coupled to the wellbore by a process including: positioning any one, portion, or combination, of the exemplary assemblies of the present application within the wellbore, and radially expanding and plastically deforming the assembly within the wellbore.

[0019] A system for forming a wellbore casing has been described that includes means for positioning any one, portion, or combination, of the exemplary assemblies of the present application within a borehole that traverses a subterranean formation, and means for radially expanding and plastically deforming the assembly within the borehole.

[0020] A method of providing a fluid tight seal between a pair of overlapping tubular members has been described that includes forming one or more stress concentrators within at least one of the tubular members, and radially expanding and plastically deforming the tubular members. In an exemplary embodiment, the tubular members are threadably coupled, and the stress concentrators are formed above the threaded coupling.

[0021] In an exemplary embodiment, the stress concentrators comprise surface grooves formed in at least one of the tubular members.

[0022] It is understood that variations may be made in the foregoing without departing from the scope of

the invention. For example, the teachings of the present illustrative embodiments may be used to provide an insulated wellbore casing, a pipeline, or a structural support. Furthermore, the elements and teachings of the various illustrative embodiments may be combined in whole or in part in some or all of the illustrative embodiments. In addition, the external sleeve 26 may be omitted. Furthermore, one or more of the stress concentration grooves, 14a, 14b, 24a, and/or 24b, may be omitted. In addition, the stress concentration grooves, 14a, 14b, 24a, and/or 24b may be provided in any geometric shape capable of concentrating stresses. Furthermore, the stress concentration grooves, 14a and 14b, may or may not be positioned in opposing relation to the stress concentration grooves, 24a and 24b. In addition, the first and second tubular members, 10 and 22, may or may not be threadably coupled to one another, and the threads, 16 and 18, of the first and second tubular members may be any type of threads.

[0023] Although illustrative embodiments of the invention have been shown and described, a wide range of modification, changes and substitution is contemplated in the foregoing disclosure. In some instances, some features of the present invention may be employed without a corresponding use of the other features. Accordingly, it is appropriate that the appended claims be construed broadly and in a manner consistent with the scope of the invention.

Claims

1. An assembly, comprising:
a first tubular member comprising external threads; and
a second tubular member comprising internal threads coupled to the external threads of the first tubular member;
wherein at least one of the first and second tubular members define one or more stress concentrators.
2. The assembly of claim 1, further comprising:
an external sleeve coupled to and overlapping with the ends of the first and second tubular members.
3. The assembly of claim 1, wherein one or more of the stress concentrators comprise surface grooves formed in the surfaces of at least one of the first and second tubular members.
4. The assembly of claim 1, wherein the stress concentrators are defined above the internal and external threads of the first and second tubular members.
5. A method for forming a wellbore casing, comprising:
positioning the assembly of claim 1 within a borehole that traverses a subterranean formation; and
radially expanding and plastically deforming the assembly within the borehole.
6. A method for forming a wellbore casing, comprising:
positioning the assembly of claim 2 within a borehole that traverses a subterranean formation; and
radially expanding and plastically deforming the assembly within the borehole.
7. A method for forming a wellbore casing, comprising:
positioning the assembly of claim 3 within a borehole that traverses a subterranean formation; and
radially expanding and plastically deforming the assembly within the borehole.
8. A method for forming a wellbore casing, comprising:
positioning the assembly of claim 4 within a borehole that traverses a subterranean formation; and
radially expanding and plastically deforming the assembly within the borehole.
9. An apparatus, comprising:
a wellbore that traverses a subterranean formation; and
a wellbore casing positioned within and coupled to the wellbore;
wherein the wellbore casing is coupled to the wellbore by a process comprising:
positioning the assembly of claim 1 within the wellbore; and
radially expanding and plastically deforming the assembly within the wellbore.
10. An apparatus, comprising:
a wellbore that traverses a subterranean formation; and
a wellbore casing positioned within and coupled to the wellbore;
wherein the wellbore casing is coupled to the wellbore by a process comprising:

positioning the assembly of claim 2 within the wellbore; and
radially expanding and plastically deforming the assembly within the wellbore.

11. An apparatus, comprising:
a wellbore that traverses a subterranean formation; and
a wellbore casing positioned within and coupled to the wellbore;
wherein the wellbore casing is coupled to the wellbore by a process comprising:
positioning the assembly of claim 3 within the wellbore; and
radially expanding and plastically deforming the assembly within the wellbore.
12. An apparatus, comprising:
a wellbore that traverses a subterranean formation; and
a wellbore casing positioned within and coupled to the wellbore;
wherein the wellbore casing is coupled to the wellbore by a process comprising:
positioning the assembly of claim 4 within the wellbore; and
radially expanding and plastically deforming the assembly within the wellbore.
15. A system for forming a wellbore casing, comprising:
means for positioning the assembly of claim 1 within a borehole that traverses a subterranean formation; and
means for radially expanding and plastically deforming the assembly within the borehole.
16. A system for forming a wellbore casing, comprising:
means for positioning the assembly of claim 2 within a borehole that traverses a subterranean formation; and
means for radially expanding and plastically deforming the assembly within the borehole.
17. A system for forming a wellbore casing, comprising:
means for positioning the assembly of claim 3 within a borehole that traverses a subterranean formation; and
means for radially expanding and plastically deforming the assembly within the borehole.
18. A system for forming a wellbore casing, comprising:
means for positioning the assembly of claim 4 within a borehole that traverses a subterranean formation; and
means for radially expanding and plastically deforming the assembly within the borehole.
19. A method of providing a fluid tight seal between a pair of overlapping tubular members, comprising:
forming one or more stress concentrators within at least one of the tubular members; and
radially expanding and plastically deforming the tubular members.
20. The method of claim 19, wherein the tubular members are threadably coupled; and
wherein the stress concentrators are formed above the threaded coupling.

21. The method of claim 19, wherein the stress concentrators comprise surface grooves formed in at least one of the tubular members.

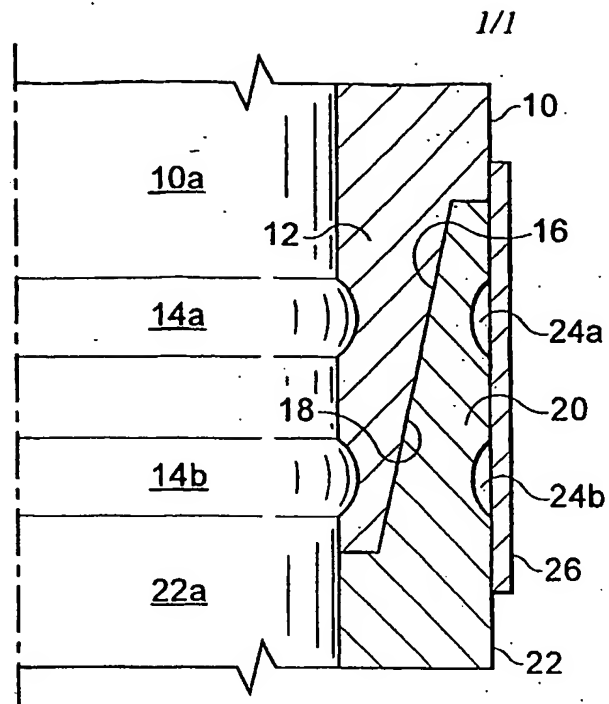


Fig. 1

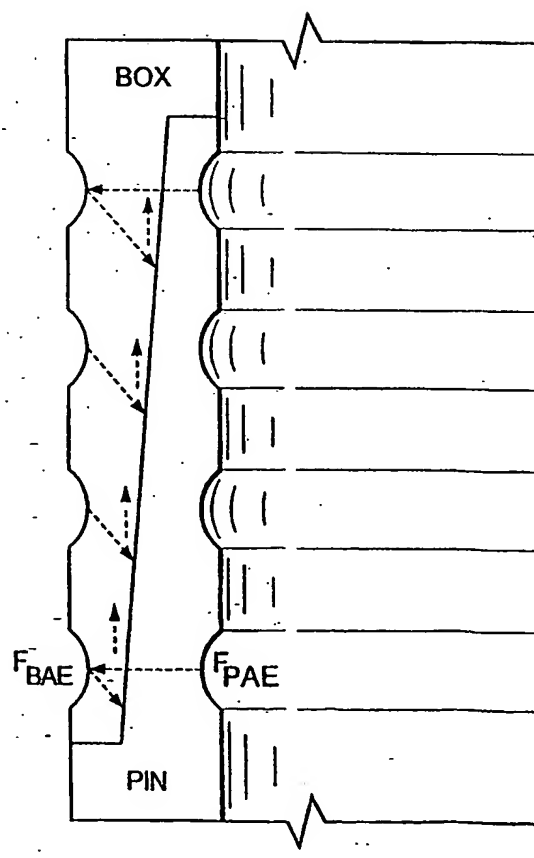


Fig. 2

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